SCIENTIFIC MANPOWER RESOURCES OF THE USSR

Address presented by Herbert Scoville, Jr. at the National Electronics Conference, Chicago, Illinois, on 3 October 1956.

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As you all know, the scientific-technical manpower shortage is a matter of real concern in this country. I am sure that at this National Electronics Conference, one would find that there are many more people recruiting scientists than there are people looking for jobs. The electronics industry is probably one of the most critical from the point of view of shortage of technical manpower. Since there are not enough electrical engineers to go around, United States industries are directing their competitive skill toward luring engineers and scientists to their companies.

This competition for scientific manpower is not limited to industries within the United States, but also exists between nations such as the United States and the Soviet Union. In this technological age, that nation with the greatest supply of high quality scientific manpower will be the one to lead the world. It is for that reason I believe it is useful to spend some time studying the scientific manpower resources in the USSR.

The analysis of manpower resources can be divided into two main parts. First, there is the quantitative aspect, i.e., the number of trained people in various fields and the rate at which this manpower pool is being increased. However, second and probably most important, is the quality of the scientific manpower which is available to the Soviet Union. It is the qualitative aspects which are of course most difficult to evaluate, but I shall attempt to analyze this part of the problem as best one can, first, by looking at the educational system and, second, at the quality of the output of the Soviet scientists.

Today, the United States and the Soviet Union each has a scientific technical manpower force of about 1.2 million. In research and teaching, the Soviet Union has a force only about 2/3ds that of the United States (175,000 vs 265,000). In research alone, they have only about half the number we have (120,000 vs about 210,000). On the average each year, though we turn out 10% more college graduates than they, they graduate many more in science and engineering than we do. For example, in 1955, 60% of Soviet full-time students graduated in scientific-technical fields as compared to only about 25% in the United States. In engineering alone, the Soviet Union graduated twice as many as did the United States.

Chart 1, Graduates per Year in All Scientific Fields, shows the steady increase in both countries in numbers of graduates in all science fields from 1930 to 1960. In 1930, both countries were almost equal, each graduating about 36,000 science students. The 1933 drop to 19,000 in the Soviet curve resulted from a lengthening of courses. The rise in 1935 (in the Soviet curve) reflects the expanded enrollments in 1930/32. Both

After completing high school, the better Soviet students enter higher educational institutions. Honor students are admitted without taking entrance examinations, but all others must pass stiff, competitive exams in Russian language and literature, mathematics, physics, chemistry and one foreign language. Most examinations are oral and it may be of some interest to describe their nature. Several days in advance of the date of the test, a student is given a compilation of more than 50 sets of questions, any one of which he may get on his exam. Then on the day of the test, he selects by chance one set of questions on which he must report. He is given about 20 minutes to collect his thoughts and then must stand up in front of the Board of Examiners and give an oral presentation of the answers. This type of exam would, I am sure, be extremely difficult for students of high school age in this country. It teaches students to think on their feet and be able to present their ideas in an understandable form. Providing the questions to the students several days in advance of the test does have, in my opinion, the drawback of putting a premium on the ability to cram for an exam. A student with a good memory might, by very vigorously studying in the few days prior to these tests, get passable marks and yet not have a true appreciation of the subject.

Future Soviet engineers and scientists are trained at one of three types of higher educational institutions:

(1) Engineering and technical colleges offer 4-5 year courses in specialized fields such as machine building, construction, and agricultural mechanization. These colleges prepare engineers and specialists for particular industries. Eight of these colleges are devoted entirely to training in electronics and radio technology. Many others have extensive courses in these fields.

(2) Polytechnic institutes offer 4-6 year courses in broader engineering fields such as civil, electrical, and metallurgical engineering. Students graduate as production engineers and enter the economy. Out of the 25 such institutes in the Soviet Union, 20 have energetics or electrotechnical faculties and 13 have faculties of radio technology or electrophysics.

(3) Universities offer 5-5½ year courses in fundamental sciences. Graduates enter research or teaching--the better graduates are directed to research. All 34 universities in the Soviet Union provide good basic training in physics, mathematics, and electronics.

Almost half a million students enter these Soviet colleges each year. They spend, as indicated, 4-6 years in a rigorous course of study.

(1) They use, of course, propaganda appeals, much as we do, stressing monetary and prestige factors, and in addition point out that it is the Soviet student's duty to prepare himself for usefulness in achieving socialist supremacy.

(2) Another very potent method of channeling students into desired fields is the threat of military draft. Students who enroll at particular specialized schools or in certain courses are given total draft exemptions or continuing deferments. For example, during the war a law was passed listing some 85 technical colleges whose students would be totally exempt from military draft as long as they successfully continued their studies in engineering and technical fields--fields in which there were definite needs. The law still remains in force today.

(3) Also, each college and university has a quota system. There are always more applicants than vacancies in scientific and technical fields. When shortages of specialists are anticipated, quotas are raised thereby admitting larger numbers of people.

(4) Scholarships and stipends serve to channel students into desired study areas. Scientific or engineering students receive more rubles per month than do their fellows who study, say, history. As State needs change, of course, so also does the amount of stipend in a given subject field.

(5) Finally, the larger number of people who have a basic technical training at least at the high school level permits a high degree of selectivity in the use of the scientific manpower resources. The inferior students can be weeded out or placed in positions requiring less ability. Too often in this country, it has been necessary to place people in positions for which they were not adequately qualified, because the supply of trained people which are being fed into the scientific manpower hopper is too small to satisfy even the major demands.

A quarter of a million students each year successfully complete their studies and graduate from college in the Soviet Union. Here again, the State steps in--graduates are assigned to jobs in the economy. Though some graduates may occasionally use outside influence or political "pull" to get desired assignments, most students consider it just that they work wherever the State assigns them. After all, they reason, the State paid for their education and training and, therefore, they are obligated to repay the State by their work. The

program, but the reactors which have been shown to the West have not demonstrated any outstanding new developments. They do, however, have an extensive program for developing nuclear power since their Sixth Five-Year Plan calls for the completion by 1961 of plants with a capacity of 2 to 2½ million kilowatts. If successful in achieving this goal, this would be a major advance, but it must be remembered that such a program might also produce substantial quantities of fissionable materials for military purposes.

They have also demonstrated ability in the field of aeronautics. The development of the TU 104, a Jet Transport plane, places the Soviet Union in a strong competitive position in the design of modern long range transports. Three of these aircraft were recently used to bring the Russian Ballet to London and they will shortly be placed into regular use between Prague, Moscow and points East.

The Soviets have recently announced the existence of a number of high-speed electronic digital computers. The largest of these, the BESM, is comparable to some of the better high speed computers in the United States and United Kingdom, although not quite as good as a recently developed United States computer. Nesmeyanov, President of the USSR Academy of Sciences, has announced that high speed computer research is one of a number of areas of fundamental importance in which the Soviets will concentrate their efforts. As he stated, research in this field is likely to lead to a scientific breakthrough.

And this brings us to the field which is of some interest to you people, electronics. In virtually all branches of electronics, with the possible exception of high-power radio technique, the Soviets were far behind the West at the end of World War II. Perhaps in no other field of science and technology, with exception of the nuclear energy field and guided missiles, has the Soviet progress of the last 10 years been so intense and productive. Today, the USSR is a major factor in electronics and a potent challenger of the electronics leadership of the United States. The Soviets are the world leaders in the relatively new branch of electronics of radio astronomy. They have maintained high competence in communication theory. They have reached high native competence in the field of electronics equipment and instrumentation directly relevant to their military requirements. In the field of "consumers" or civil electronics (such as television, civil telephone and telegraph), they are well behind the West, even by their own standard. They propose, however, to improve this field under their Sixth Five-Year Plan. Recent visitors to Russia were impressed by the increased number of TV sets available this year in the stores.

multichannel service in a system up to 2500 km long, and STRELA T for transmitting several television channels. A true wide-frequency multichannel radio-relay system has been produced in a prototype form, capable of handling up to 12 television channels or up to 3,000 telephone channels. The system is to operate at wavelengths not to exceed 7 to 9 cm and in lengths up to several thousands of kilometers (Moscow, TASS, July 1956). The Soviet Sixth Five-Year Plan calls for some 10,000 km of new radio-relay lines and an increase of their 1950 radio-relay facilities some 60 times. A new Soviet high speed facsimile equipment has been announced recently (Promyshlenno-Ekonomicheskaya Gazeta, July 1956) and a fully electronic high-speed teleprinter is reported under development, the first model to use vacuum tubes and the later miniaturized version to use transistors. (Evening Moscow, May 1956)

In summary, (1) the Soviets are not at present ahead of the United States in total scientific and technical manpower, but they are advancing rapidly and, if present trends continue, will surpass the United States; (2) the Soviet educational system is designed at all levels to turn out scientists and engineers; and, (3) the quality of Soviet developments is good in almost all its fields which have been emphasized, and electronics is certainly one of those in which they have demonstrated a high position of native competence.

CHART 1

GRADUATES PER YEAR IN ALL SCIENTIFIC FIELDS

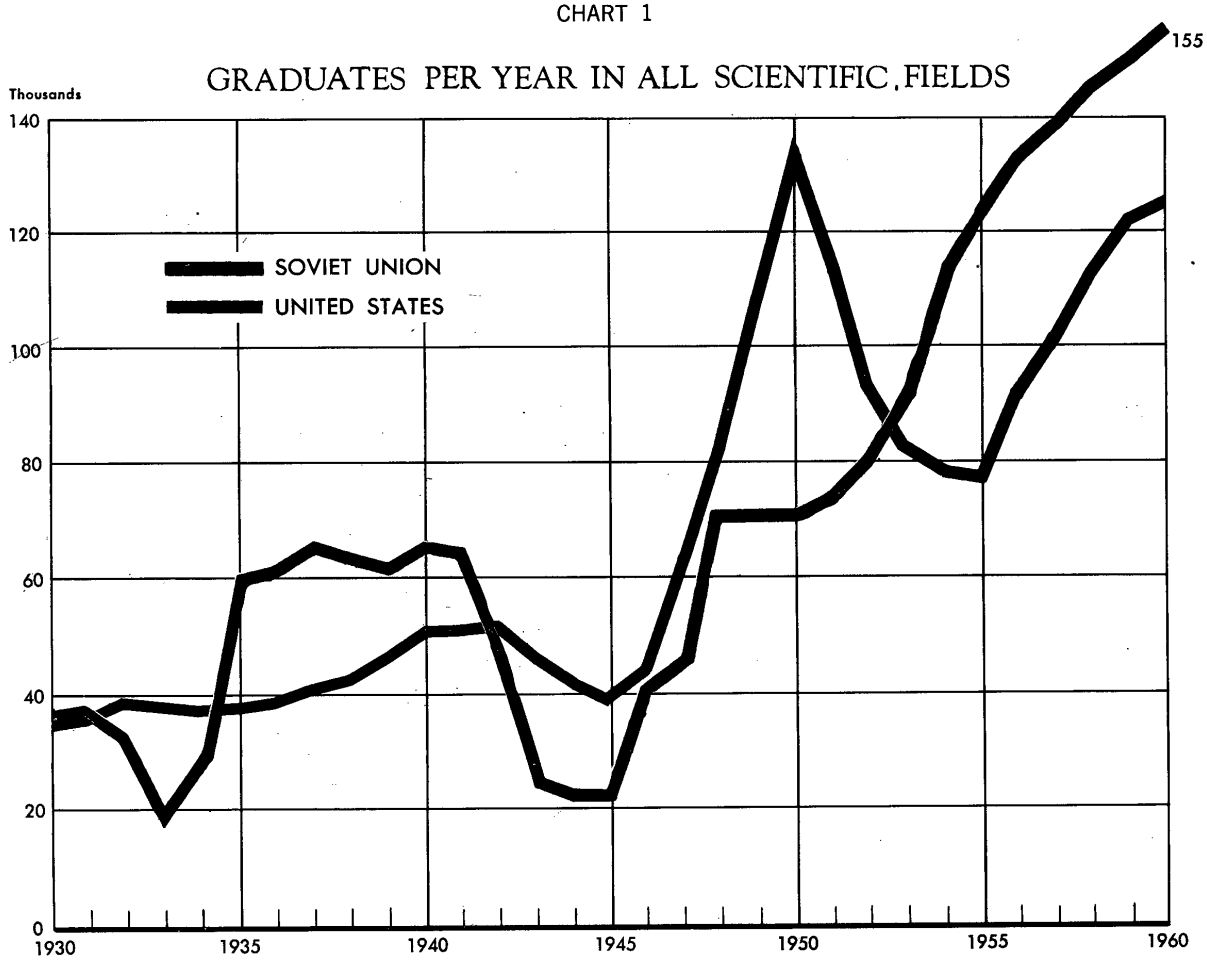

CHART 2

GRADUATES PER YEAR IN PHYSICAL SCIENCES AND ENGINEERING

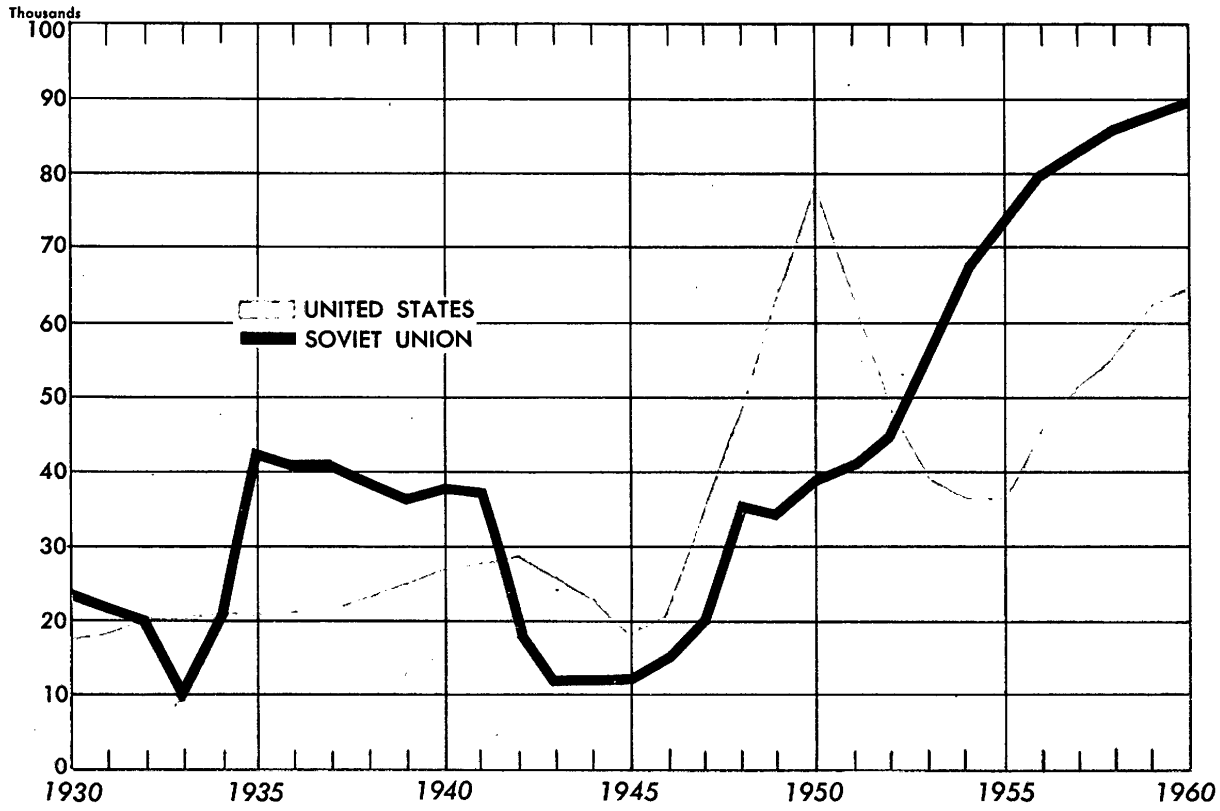

CHART 3

HIGHER DEGREES IN SCIENCE AWARDED ANNUALLY